

# Globalized geoscience

A high percentage of international collaborations in a country's research output can be a sign of excellent networks, or of a reliance on know-how imports. Caution is needed in the latter case, but international collaborations make research more powerful.

Scientists naturally welcome a global approach. This is particularly true for Earth scientists who rely on field work from locations all over the planet. In a connected world, scientists can build on each other's work across borders instead of reinventing the wheel country by country, and free communication between researchers generates uncommon perspectives and thus new ideas. Five years ago, an analysis of 25 million papers across all fields showed that international collaboration has been rising dramatically over the past three decades, and has become integral to generating cutting-edge science (*Nature* **497**, 557–560; 2013). A closer look at *Nature Geoscience* papers reveals that the fraction of international collaborations in the research published since the 2008 launch has likewise risen dramatically, from less than half to about two-thirds (Fig. 1a).

Based on the analysis of 1,375 primary research articles published between 2008 and 2017 by *Nature Geoscience*, only 52 out of 114 papers published in 2008 had authors from more than one country, whereas this was true for 91 out of 133 published papers in 2017. The level of internationalism has also grown: in 2017, 37% of the papers were based on joint research that involved at least three countries, compared to 20% in 2008.

The number of international papers varies by country. Not surprisingly, the United States, the United Kingdom (UK) and Germany, who were involved in more than 60% of our publications, also published the greatest absolute number of international collaboration papers in *Nature Geoscience* during 2008–2017.

In terms of the contribution of international research to all papers from a particular country, broadly speaking, countries that have high numbers of articles in *Nature Geoscience* tend to have lower fractions of international papers (Fig. 1b). There are a few exceptions. European Union countries — notably Germany and France — tend to be more collaborative than expected from their high *Nature Geoscience* research output, potentially due to European funding initiatives. On the other hand, Japan and Israel are relatively insular. All 54 countries with 22 or fewer papers in *Nature Geoscience* between 2008 and 2017 feature 100% participation in international collaborations.

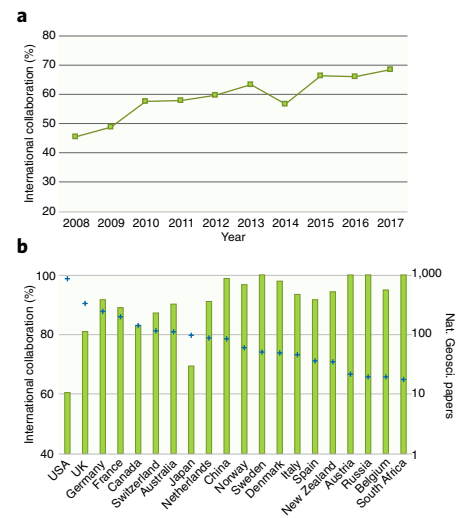
China, too, is an interesting case. Here, at 99%, the level of collaboration with other countries is exceptionally high for a country that is among the top ten locations of *Nature Geoscience* authors. This high level of internationalism could be a sign of China's reliance on external know-how to conduct world-class Earth science research — possibly combined with a relatively high availability of funds that make it an attractive partner.

However, for China, as well as other countries that are still building scientific capacity, international collaboration can be a double-edged sword. It certainly helps researchers to quickly acquire research skills, but there is also a risk of falling into over-reliance, which may delay building national capacity to produce independent world-class research.

Despite the potential side effects of international collaboration at a regional scale, diverse teams benefit Earth science research. International collaboration helps to incorporate local knowledge of geological and climatic conditions, and enables scientists to compare and contrast different regions. All of this helps with the discovery of more widely applicable, general findings. International research typically achieves a greater scientific influence than domestic output (*Nature* **497**, 557–560; 2013), probably at least partly as a result of the effect of a wider range of ideas and backgrounds that contributed to the findings. Another likely reason is that international collaborations tend to reach a wider network of researchers through the authors' contacts.

In *Nature Geoscience*, papers with authors from more than one country have received 16% more citations on average than those without. For example, the most highly cited research article in *Nature Geoscience* so far comes from an international team comprised of scientists from four countries.

Political turbulence, however, has added to the uncertainties in international collaboration in science. With the UK, one of Europe's largest scientific powerhouses, set to leave the European Union, it is unclear to what level it will benefit from pan-European joint research funding in the future. Although the average percentage of international research here is not as high as in some mainland European countries, it has risen



**Fig. 1 | International collaboration rates in *Nature Geoscience* from 2008 to 2017.** **a**, The percentage of research articles with authors from more than one country has risen steadily since the journal launch in 2008. **b**, Among the 20 countries with the largest number of co-authored papers in *Nature Geoscience* between 2008 and 2017 (declining left to right, crosses represent number of papers), the percentage of international collaboration generally decreases as the number of *Nature Geoscience* papers increases.

steadily since 2008. And the UK topped the number of research and innovation projects in the first three years (2014–2016) of Horizon 2020, the European Union's largest science funding programme. How collaborations between UK and European countries will evolve after the UK leaves the European Union has not yet been settled.

Before the internet and cheap and rapid international travel, opportunities for a scientist to work with researchers on the other side of the world were much more limited. In the twenty-first century, by contrast, the world has become closely connected. Ironically, new obstacles are built up by us. In the interest of advancing humanity's knowledge base, we should strive to make the international collaboration in science as resilient as possible. □

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